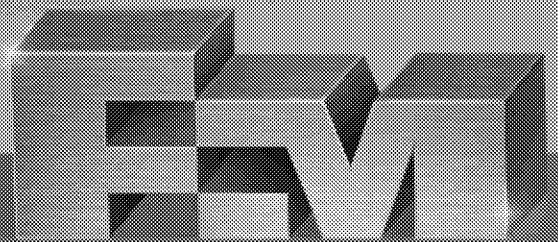
Climax Molybdenum
A Freeport-McMoRan Company

Risk Communication Challenge – Updating the Molybdenum Science and Guidance



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Molybdenum Issue in the State of CO

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- **Issue:**
  - **The State of CO is waiting for federal guidance before it updates its molybdenum (Mo) water quality standard (WQS)**
  - **EPA IRIS and draft 1993 Health Advisory for molybdenum are based on outdated information**
  - **Recent peer-reviewed studies should be considered in revising state and federal molybdenum values**
  - **Time is of the essence – the State has postponed action in anticipation of federal guidance**

- **Request:**
  - **EPA must define next steps in addressing the Risk Communication Challenge regarding molybdenum; the recent toxicology studies mandate a change**

Climax Mine History

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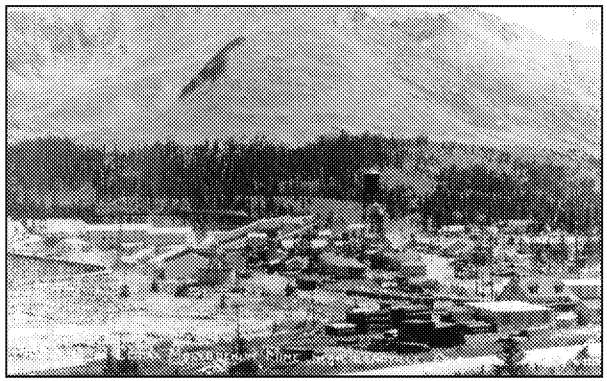
- 1879 - Charles Senter staked claims
- 1895 - Mineral identified as molybdenite
- 1918 - Climax Molybdenum Company formed
- During WWII supplied the huge allied molybdenum demand
- Became the world's largest underground mine
- Later converted to an open-pit operation
- Modernized to resume full-scale operations in 2012
- Climax direct employment: 427
- Significant contributor to local/rural economies (e.g., about 50% of Lake County's property tax revenue)



Molybdenum Has Varied World-Wide Applications

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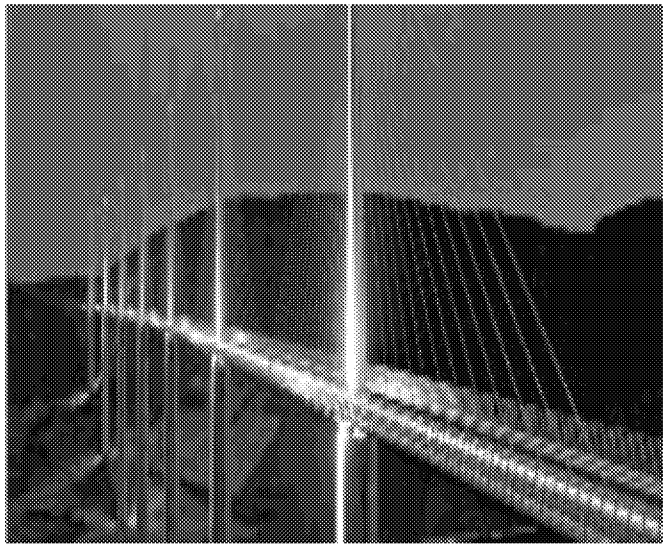

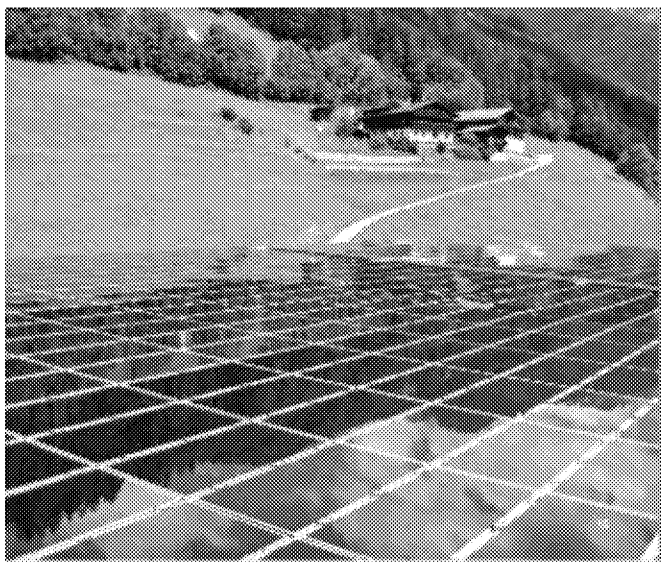

- **Stainless and Alloyed Steels**
  - Lighter, stronger, corrosion resistant, and 100% recyclable
- **De-sulfurization Catalysts**
  - Removes sulfur from diesel and gas
- **Flat Screen electronics**
- **Renewable energy**
- **Oil and gas production and exploration**
- **Lubricants**
- **Fertilizers**
- **Medical Imaging**
- **Water Treatment**

Climax Mine Has Comprehensive Water Management Systems

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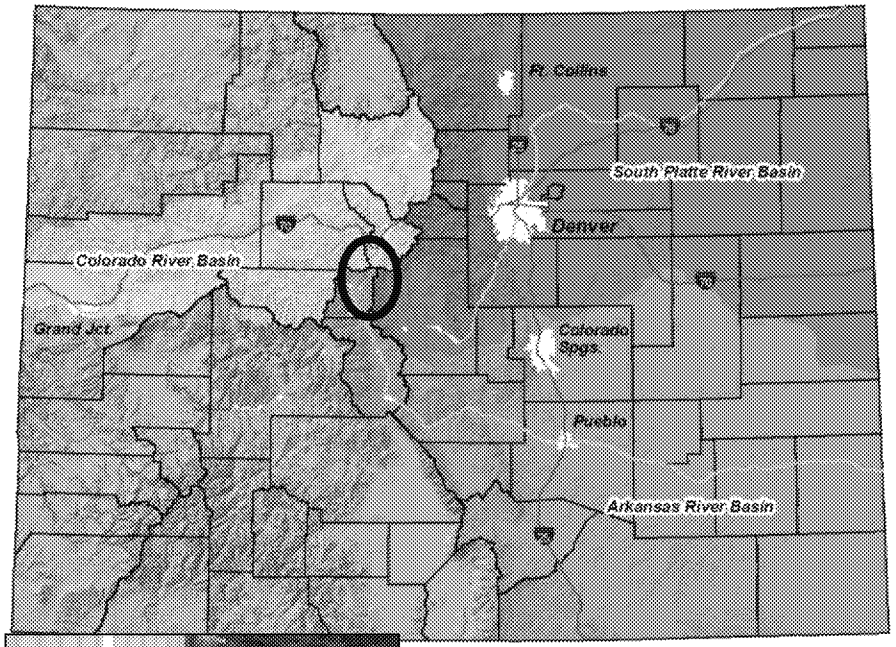
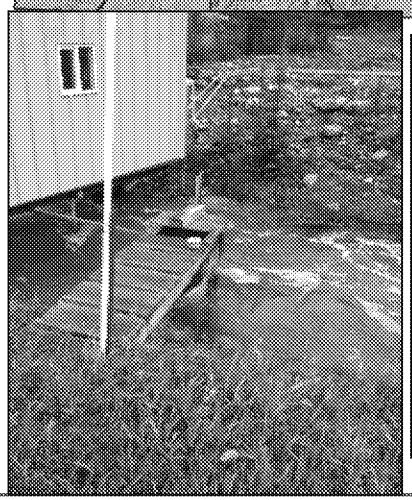
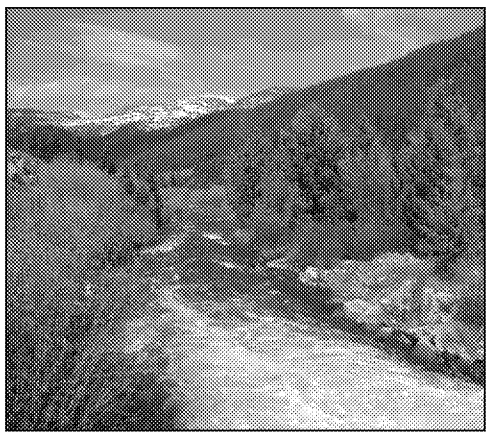
- Located at the top of Continental Divide, with annual snowfall average of 275 inches
- Water management numbers
  - 10,000 GPM process water (recycled) to mill
  - 3,000 to 14,000 GPM treated mine drainage
  - Over 100,000 GPM clean water diverted offsite at peak runoff
  - 42 miles of pipelines, 8 pumping stations and 25 FT staff
- Treatment of mine drainage for process water and/or release to Tenmile drainage basin (CDPS Permit)
  - Stage 1 - Sludge Densification Plant (SDP)
  - Stage 2 - Property Discharge Water Treatment Plant (PDWTP)
- Interceptor canal systems to divert clean runoff







Historical Evolution of Underlying Molybdenum Toxicology Data

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Study	Date	Performed On	Reproducible	Type	Calculated State Standard (µg/L)	Data Endorsement	Regulatory Suitability	Comment	LOAEL vs. NOAEL (mg/kgBW/day)
Koval'skiy	1961	Humans	No	Population Survey	35	None	No	Basis for Current IRIS Number	0.14 (LOAEL)
Fungwe	1990	Rats	No	90-Day Dose Response	210	None	No	PhD Dissertation	0.9 (NOAEL)
Murray, et al	2013	Rats	Yes	90-Day Sub-chronic Toxicity Study	3967	OECD	Yes	Peer Reviewed/Published	17 (NOAEL)
Murray, et al	2014	Rats	Yes	Prenatal Developmental Toxicity Study	9333	OECD	Yes	Peer Reviewed/Published	40 (NOAEL)
Murray, et al	2019	Rats	Yes	Two-Generation Reproductive Toxicity Study	9,000	OECD	Yes	Peer Review/Published	17 (NOAEL)

Recent Studies Sponsored by International Molybdenum Association

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- **IMOA sponsored studies to meet the requirements of multiple international regulatory initiatives in the absence of reliable scientific studies on molybdenum**
- **IMOA sponsored study results were internationally accepted independent studies**
  - F. Jay Murray et al. 90-Day subchronic toxicity study of sodium molybdate dihydrate in rats. Regulatory Toxicology & Pharmacology, Vol. 70 (2014), 579-588.
  - F. Jay Murray et al. Developmental toxicity study of sodium molybdate dihydrate administered in the diet to Sprague Dawley rats. Reproductive Toxicology, Vol. 40 (2014), 202-208.
  - F. Jay Murray et al., A two-generation reproductive toxicity study of sodium molybdate dihydrate administered in drinking water or diet to Sprague-Dawley rats. Reproductive Toxicology (Mar. 2019).

Molybdenum Is Essential to the Life Cycle

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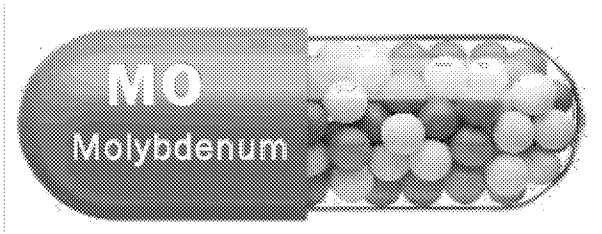

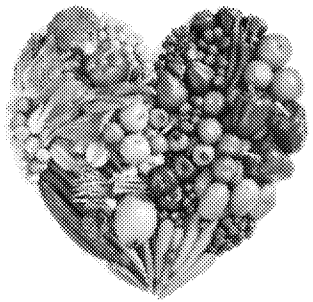

- **Molybdenum is not a "heavy metal"**
  - **Different from Arsenic, Beryllium, Cadmium, Hexavalent Chromium, Lead, and Mercury**
- **Molybdenum does not build up in the body or bioaccumulate**
- **Molybdenum is an essential trace element that is significant for the biological functions of our bodies and plant life**
  - **Molybdenum is in our daily vitamins**

Additional information available by visiting imoa.info

History of Molybdenum (Mo) Colorado Water Quality Standards

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- 2007 Basic Standards Rulemaking (Ground Water):
  - Water Quality Control Division (WQCD) proposed, and Commission (WQCC) adopted 35 µg/L, relied on 1993 EPA RfD based on Kovalskiy (1961)
- 2010 Basic Standards Rulemaking (Surface Water): Water quality standard (WQS) for Mo water supply
  - WQCD proposed 35 µg/L based on Koval'skiy
  - WQCC adopted 210 µg/L based on Fungwe (1990)
- 2014 Upper Colorado River Basin Rulemaking:
  - Lower Tenmile Creek Mo water supply WQS = 210 µg/L
  - WQCC adopts temporary modification of "current conditions," based on significant uncertainty with underlying Mo standard
    - Two IMOA studies were available but not used, a third was anticipated in the future

2017 Special Rulemaking Hearing - Colorado Water Quality Standards

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- Climax proposed a WQS of 9,000 µg/L for Mo water supply based on the three IMOA studies that refute both Koval'skiy and Fungwe
- WQCD responded that no change to the WQS was appropriate until:
  - Third IMOA study is peer reviewed and published
  - ATSDR revises its draft Mo toxicological profile or EPA revises draft 1993 health advisory
    - Draft ATSDR profile did not consider third IMOA study
    - Draft EPA health advisory still based on Kovalskiy
- Rulemaking continued by WQCC in two parts:
  - Jan. 2018: WQCC to consider extension of temporary modification
  - Nov. 2019: WQCC to consider revisions to Mo WQS

2018/2019 Rulemaking Decisions

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- January 2018 Rulemaking:
  - WQCC extended temporary modification of "current conditions" on Lower Tenmile Creek until June 30, 2020
  - WQCC Statement of Basis and Purpose (SBP): Climax should investigate Mo sources, source controls, and treatment alternatives
- December 2018 Rulemaking:
  - WQCC took no action on the temporary modification
  - WQCC SBP: Climax to submit report regarding the Jan. 2018 SBP by July 1, 2019
- November 2019 hearing postponement
  - No update to Toxicological Profile from ATSDR
  - No revision to IRIS or draft Health Advisory from EPA
- December 2019 hearing scheduled to consider temporary modification of "current conditions" on Lower Tenmile Creek

Status of ATSDR Process

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- ATSDR revised draft Toxicological Profile for Molybdenum
  - ATSDR issued an April 2017 draft Toxicological Profile for public comment, which did not have the benefit of the third toxicity, then in progress
  - Now that the third toxicity study has been peer-reviewed and published, ATSDR is reportedly working on revisions to its Toxicological Profile
  - Completion date unknown, although communications indicate the draft profile is under review

Status of EPA Reviews/Need for Change

- EPA IRIS and draft 1993 Health Advisory are based on now-discredited 1961 study by Koval'skiy
- EPA has continued to publish the draft Health Advisory value, including in the 2018 Edition of the Drinking Water Standards and Health Advisory Tables
- EPA Office of Water recognizes Mo draft Health Advisory is out of date, but may not have the resources to timely update it
- EPA Region 8's Statement in 2017 Molybdenum Standards Rulemaking in CO:
  - Results of the three studies submitted by Climax "should be used to derive an Ambient Water Quality Standard instead of the study posted on EPA's IRIS site (Koval'skiy et al., 1961) and instead of Fungwe et al. (1990)."
  - Based on input by R8 expert toxicologist, EPA R8 calculated 10,000 µg/L TVS "would be protective of the water supply use classification and consistent with Clean Water Act requirements."